REMARKS

This is intended as a full and complete response to the Final Office Action dated May 19, 2009, having a shortened statutory period for response set to expire on August 19, 2009. Please reconsider the claims pending in the application for reasons discussed below.

Claims 1, 20, 21, 23, 24, 26 and 28 now stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,353,121 ("Ray") in view of U.S. Patent No. 4,520,467 ("Berni"). Applicants respectfully submit that neither Ray nor Berni, alone or in combination, teaches seismic data representative of acceleration wavefield, as recited in claim 1.

Ray is generally directed towards using hydrophone arrays to gather seismic reflections so that the corresponding primary and ghost reflections from a common interface are gradually spaced apart. (See Ray, abstract). The hydrophone arrays include **acceleration-cancelling hydrophones** that remove or cancel acceleration wavefields from the seismic data. (See Ray, column 7, lines 32-35). As such, the seismic data obtained and processed by Ray includes **only** velocity data. (See Ray, column 10, lines 16-20; column 12, lines 42-44, lines 53-56; column 12, line 67 – column 13, line 4).

The Examiner takes the position that Ray discloses applying a gain recover to the seismic data; applying a normal moveout correction to the seismic data, muting the seismic data, stacking the seismic data; and applying a time migration to the seismic data. (See office action, page 2). Although Ray may mention performing some of these steps on seismic data, the seismic data described in Ray **does not represent acceleration wavefield**, as recited in claim 1. In fact, Ray teaches away from using seismic data representative of acceleration wavefield by cancelling the acceleration data from its seismic data using acceleration cancelling hydrophones. It would not be possible for Ray to process seismic data using seismic data representative of acceleration wavefield, because Ray requires processing seismic data using only velocity data. Therefore, Ray does not teach applying a gain recover to the seismic data; applying a normal moveout correction to the seismic data, muting the seismic

data, stacking the seismic data; and applying a time migration to the seismic data, wherein the seismic data represents acceleration wavefield.

The Examiner takes the position that the missing limitation, the seismic data representing acceleration wavefield, is taught in Berni. (See office action, page 3). The Examiner then explains that it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method of Ray with the steps of Berni. Applicants respectfully traverse this position. Berni is directed at eliminating ghosts from seismic signals using a method that employs **both** a pressure sensor and a motion sensor. (See Berni, abstract). Applicants' claimed invention, however, focuses performing its method using seismic data representative of acceleration wavefield, as recited in claim 1. In contrast, **Berni requires both pressure data and particle motion data** in order to eliminate ghosts from its seismic signals. In fact, throughout its disclosure, Berni describes processing the output signal from a hydrophone to sense the acoustic pressure waves and the output signal from a motion sensor to sense the movement of water particles in order to eliminate ghosts from its seismic signals. (See Berni, column 2, line 67 – column 3, line 12; column 3, lines 54-58; column 3, line 66 – column 4, line 3; column 4, lines 4-14, 31-33, 55-62; column 5, lines 3-36; Figures 2 & 5). For instance, Berni's process for filtering seismic data is described in column 5, lines 3-36, which has been reproduced below for the Examiner's convenience.

> The particle acceleration and pressure wave signals can be represented by the functions $M_a e^{j\varphi} a$ and $M_p e^{j\varphi} p$, respectively, which are illustrated in FIGS. 4(a) and 4(b). For the sake of clarity, the spectra of a single, base reflection wavelet occurring at an arbitrary time zero has been considered in FIG. 4. The frequency spectra associated with both the hydrophone and accelerometer signals exhibit periodic notches caused by the secondary reflections from the surface of the water. The notches in the pressure wave signals occur at multiples of the frequency defined by the wave propagation velocity of the body of water, which is approximately 1500 meters per second, divided by two times the depth of the detector. The first notch frequency is equal to the reciprocal of the time interval T, which is the time for a wave to propagate from the detector to the surface and back to the detector. **The notches in the particle acceleration signals occur at frequencies midway between the notches in the pressure wave spectra. Thus, peaks in the particle velocity response occur at pressure wave notch frequencies and vice versa.** Filters 32 and 34 consist of the inverses of the particle acceleration and pressure wave functions, i.e.,

$$PF_a = (1/M_a)\, e^{-j\varphi a} \text{ and } PF_p = (1/M_p)\, e^{-j\varphi p}$$

> Filtering or multiplying in the frequency domain with the functions PF_a and PF_p accomplishes the normalization and zero phasing, except that the phase shifts caused by the nonzero time of arrival of the particular wavelet are preserved. (Berni, column 5, lines 3-36, Emphasis added).

As seen above, Berni describes determining the notches in the particle acceleration signals at frequencies midway between the notches in the pressure wave spectra. Further, Berni uses the above mentioned relationship to determine the peaks in the particle velocity which occur at pressure wave notch frequencies. In this manner, it is apparent that Berni requires both pressure and acceleration data to perform its method in eliminating ghosts from seismic data. Therefore, Berni does not teach seismic data representative of acceleration wavefield.

Additionally, Ray and Berni are not combinable. MPEP 2143.01 states that if the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious. Here, the Examiner proposes modifying Ray's method for gradually spacing ghost arrivals apart by using pressure and acceleration data obtained from pressure and motion sensors as disclosed in Berni. However, this proposed modification would significantly change Ray's principle operation for gradually spacing ghost arrivals apart, because a method directed to one type of data (i.e., velocity data) is typically not applicable to another type of data (i.e., pressure and acceleration data) due to the different attributes of physics involved.

As mentioned above, Ray proposes using **acceleration-cancelling hydrophones** in order to detect ghosts. Ray does not include acceleration data or wavefield in its seismic data processing. On the other hand, Berni describes using **both pressure sensors and motion sensors** for detecting the pressure and the acceleration of water particles. In this manner, the Examiner's proposal for combining Ray and Berni would render Ray's method for gradually spacing ghost arrivals useless, because **Ray requires only velocity data** to process its seismic data, while Berni

requires **pressure and acceleration data**. Therefore, using the pressure and acceleration data taught by Berni for the seismic data processing steps taught by Ray would significantly change the principle of operation of the methods taught in Ray.

Further, if the proposed modification would render the prior art invention being modified **unsatisfactory for its intended purpose**, then there is no suggestion or motivation to make the proposed modification. (MPEP 2143.01). As described above, modifying Ray to use the pressure sensors and motion sensors described in Berni would render Ray unsatisfactory for its intended purpose, because the seismic data analysis described in Ray requires only velocity data, as opposed to pressure and acceleration data that are taught in Berni.

Since neither Ray nor Berni teaches all the limitations of claim 1, and since Ray and Berni cannot be combined, claim 1 is patentable over Ray in view of Berni. Claims 20-28 are also patentable over Ray in view of Berni since they depend from claim 1. Withdrawal of the rejection is respectfully requested.

With respect to claim 23, the Examiner takes the position that Ray teaches applying a demultiple algorithm to remove events that involve multiple passes through a water column in which a receiver used to acquire the seismic data is disposed. (See office action, page 2). The Examiner points to Ray column 5, lines 8-9 as teaching this limitation. Ray states: “Static corrections are also applied to correct the ghost arrivals to datum and the phase of such arrivals is reversed.” (See Ray, column 5, lines 8-9). As seen from this section, Ray fails to teach, let alone mention, applying a demulitple algorithm. Further, the Examiner does not explain how static corrections applied to correct ghost arrivals is the same as applying a demultiple algorithm to remove events that involve multiple passes through a water column, as recited in claim 23. Since neither Ray nor Berni teaches this limitation, claim 23 is patentable over Ray in view of Berni. Withdrawal of the rejection is respectfully requested.

With respect to claim 26, the Examiner takes the position that Ray teaches applying a post-stack deconvolution algorithm to whiten a signal spectrum. (See office action, page 2). The Examiner points to Figure 15, #100 of Ray as teaching this limitation. Although #100 of Figure 15 indicates a filter deconvolution migration may be applied after the seismic data is stacked, #100 of Figure 15 does not indicate that the

deconvolution migration is used to whiten the signal spectrum, as recited in claim 26. In fact, Ray does not even mention whitening a signal spectrum anywhere in its disclosure. Since neither Ray nor Berni teaches this limitation, claim 26 is patentable over Ray in view of Berni. Withdrawal of the rejection is respectfully requested.

With respect to claim 24, the Examiner admits that Ray does not teach applying a trace equalization algorithm to the seismic data. (See office action, page 3). However, the Examiner points to Berni column 4, line 62 to column 5, line 2 as teaching this limitation. This section of Berni is reproduced below for the Examiner's convenience.

> At filters 32 and 34 the amplitude of each frequency component contained in the particle acceleration and pressure wave signals is modified or **normalized**. In addition, filters 32 and 34 remove the phase angles associated with the signals to make all of the frequency components zero phase so that the signals can be added properly after the amplitude terms are weighted by the signal-to-noise filters, as discussed hereinbelow. (Berni, column 4, line 62 to column 5, line 2, Emphasis added)

As seen above, Berni describes normalizing seismic data as opposed to applying a trace equalization algorithm to the seismic data, as recited in claim 24. Further, Berni describes normalizing both particle acceleration and pressure wave signals, as opposed to seismic data representative of acceleration wavefields, as recited in claim 1. Since neither Ray nor Berni teaches applying a trace equalization algorithm to the seismic data, claim 24 is patentable over Ray in view of Berni. Withdrawal of the rejection is respectfully requested.

With respect to claim 28, the Examiner admits that Ray does not teach equalizing amplitudes of the stacked seismic data. (See office action, page 3). However, the Examiner points to Berni column 2, lines 15-19 and lines 24-29 as teaching this limitation. These referenced sections of Berni, however, describe equalizing the amplitudes of frequency components obtained from a primary pressure wave reflected from the substrata beneath the body of water and a secondary pressure wave caused by a secondary reflection of the primary wave from the air-water interface. (See Berni, column 2, lines 1-4). As such, Berni does not describe equalizing the amplitudes of **the stacked seismic data**, as recited in claim 28. In contrast, Berni is directed at

equalizing the amplitudes of frequency components of pressure waves, which is not the same as seismic data representative of acceleration wavefield, as recited in claim 1. Since neither Ray nor Berni teaches equalizing amplitudes of the stacked seismic data, claim 28 is patentable over Ray in view of Berni. Withdrawal of the rejection is respectfully requested.

Claims 10 and 12-15 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Ray in view of Berni, and further in view of US Patent Application Publication No. 2005/0090987 ("Amundsen"). Applicants respectfully traverse the Examiner's use of Amundsen as a prior art reference in view of 35 U.S.C. § 103(c)(1), which states that the subject matter developed by another person, which qualifies as prior art only under one or more of subsections (e), (f) and (g) of section 102, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time of the claimed invention was made, owned by the same person or subject to an obligation of assignment to the same person. As such, Amundsen cannot be used to preclude the patentability of the Applicants' claimed invention because Amundsen is a published patent application defined under 35 U.S.C. § 102(e) and both Amundsen and the present application are commonly assigned.

For this reason, the analysis under 35 U.S.C. § 103(a) is provided herein below without reference to Amundsen. With respect to claims 10 and 12-15, the Examiner takes the position that Ray teaches performing various seismic data processing steps as described above with reference to claim 1. (See Office Action, page 3). However, as explained above, neither Ray nor Berni teaches seismic data representative of acceleration wavefield, which is recited in claim 10.

The Examiner admits that Ray does not teach an input interface for receiving seismic data representative of acceleration wavefield; a data processor; the seismic source and the receiver are each disposed at or on the earth's surface; the seismic source is disposed at or on the earth's surface and the receiver is disposed within a borehole; and seismic source is disposed in a water column and the receiver is located at the base of the water column. (See Office Action, pages 3-4). Berni also fails to teach these limitations. The Examiner attempts to supplement these missing limitations with Amundsen. However, since Amundsen is not a proper reference, the references of

record fail to teach or disclose these limitations. Claims 10 and 12-15 are therefore patentable over Ray in view of Berni.

Claim 16 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Ray in view of Berni and Amundsen and further in view of US Patent Application Publication No. 2004/0109389 ("Quinn"). As mentioned above, Amundsen is not a proper reference. Accordingly, the analysis is provided without reference to Amundsen. Neither Ray nor Berni nor Quinn, alone or in combination, teaches or discloses seismic data representative of acceleration wavefield, as recited in claim 10. Since claim 16 depends from claim 10 and since neither Ray nor Berni nor Quinn, alone or in combination, teaches, discloses or suggests all the limitations of claim 10, claim 16 is therefore also patentable over Ray, Berni, and Quinn. Withdrawal of the rejection is respectfully requested.

Claim 22 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Ray in view of Berni and further in view of US Patent No. 4,979,150 ("Barr"). Neither Ray nor Berni nor Barr, alone or in combination, teaches or discloses seismic data representative of acceleration wavefield, as recited in claim 1. Since claim 22 depends from claim 1 and since neither Ray nor Berni nor Barr, alone or in combination, teaches, discloses or suggests all the limitations of claim 1, claim 22 is therefore also patentable over Ray, Berni and Barr. Withdrawal of the rejection is respectfully requested.

Claim 25 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Ray in view of Berni and further in view of US Patent No. 5,642,327 ("Schiflett"). The Examiner admits that Ray does not teach applying a pre-stack deconvolution algorithm. (See office action, page 5). However, the Examiner points to Schiflett column 9, line 6 as teaching this limitation. Although Schiflett mentions a pre-stack deconvolution in the referenced section, Schiflett does not indicate that the deconvolution algorithm is used to attenuate short period of reverberations, as recited in claim 25. Since neither Ray nor Berni nor Schiflett teaches this limitation, claim 25 is patentable over Ray in view of Berni and Schiflett. Alternatively, neither Ray nor Berni nor Schiflett, alone or in combination, teaches or discloses seismic data representative of acceleration wavefield, as recited in claim 1. Since claim 25 depends from claim 1 and since neither Ray nor Berni nor Schiflett, alone or in combination, teaches, discloses or suggests all the

limitations of claim 1, claim 25 is therefore also patentable over Ray, Berni and Schiflett. Withdrawal of the rejection is respectfully requested.

Claim 27 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Ray in view of Berni and further in view of US Patent Application Publication No. 2004/0070529 ("Kamas"). Neither Ray nor Berni nor Kamas, alone or in combination, teaches or discloses seismic data representative of acceleration wavefield, as recited in claim 1. Since claim 27 depends from claim 1 and since neither Ray nor Berni nor Kamas, alone or in combination, teaches, discloses or suggests all the limitations of claim 1, claim 27 is therefore also patentable over Ray, Berni and Kamas. Withdrawal of the rejection is respectfully requested.

In conclusion, the references cited by the Examiner, neither alone nor in combination, teach, show, or suggest the claimed invention. Having addressed all issues set out in the office action, Applicants respectfully submit that the claims are in condition for allowance and respectfully request that the claims be allowed.

The prior art made of record is noted. However, it is believed that the secondary references are no more pertinent to the Applicants' disclosure than the primary references cited in the office action. Therefore, it is believed that a detailed discussion of the secondary references is not deemed necessary for a full and complete response to this office action.

Respectfully submitted,

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